THE

OF

Tropical Hydrobiology and Fisheries

(Afr. J. Trop. Hydrobiol. Fish.)

Vol. 2 No. 2 1972

East African Literature Bureau

NAIROBI DAR ES SALAAM KAMPALA

SPONSORS
Hydrobiologists from East, Central and West Africa with substantial support from other African countries, Fishery Scientists in the United States, Canada, U.K., Europe, Soviet Union and Israel.

EDITOR
Dr. J. Okedi, Director, E.A.F.F.R.O., Jinja, Uganda.

ASSISTANT EDITOR
S. Wanambwa (Mrs).

PROGRAMME
The African Journal of Tropical Hydrobiology and Fisheries will only accept original and well supported ideas on techniques, methodology and research findings from scientists, fishery officers, fishery economists and sociologists.
The Journal will therefore strengthen the African research scientist by making research material available and also increasing the awareness and utility of aquatic resources.
Its quality will conform to International standards, and will be published in English and French.

MANUSCRIPT ADDRESS
Manuscripts should be addressed to E.A.F.F.R.O., East African Freshwater Fisheries, Research Organisation, East African Community, Box 343, Jinja, Uganda.

REPRINTS
Authors will receive 60 reprints free of charge. Extra reprints may be procured on cost.

PUBLISHER
East African Literature Bureau, P.O. Box 30022, Nairobi, Kenya.

ISSUES
The Journal consists of one volume a year, consisting of two issues with approximately eighty pages each.

SUBSCRIPTION
Annual subscription within East Africa Sh. 35. Outside East Africa, East African Sh. 70, US $ 10.00

CHEMICAL, BACTERIOLOGICAL AND SENSORY EXAMINATION OF SPLIT, DRIED, SMOKED BREAM ON THE MARKET IN ZAMBIA

KO WATANABE
FAO Fish Processing Technologist, UNDP/FAO/GRZ Central Fisheries Research Institute, P.O. Box 100, Chilanga, Zambia

ABSTRACT

A critical examination of the market quality of split, dried ,and smoked bream (*Tilapia* spp.) was chemically, bacteriologically and organoleptically conducted for the period of August, 1968, to January, 1969. The aim of this survey was to obtain basic information for the development of national quality standards for the commodity.

Relationships of cooked meat score to pH, fish size, appearance and smell score, and water content were significantly correlated and responsive. Therefore, these parameters were proposed to be used as indices for the quality standards of the products.

Present Address.
c/o Nations Unies, Project SEN 64/505 B.P. 154, Dakar, Senegal

INTRODUCTION

In 1968, the Department of Wildlife, Fisheries and National Parks, Zambia, requested the Central Fisheries Research Institute (C.F.R.I.) to develop a set of national quality standards for fish and fish products for future use by fish inspection services.

For this purpose, analysis of the quality of presently marketed fish and fish products was indispensable to assure that the developed standards should essentially be applicable to the local conditions.

As a first attempt of the development of these standards, this paper describes the results of chemical, microbiological and organoleptic examination of locally prepared split, dried and smoked bream. This type of product was considered as the most prized by the Zambians and was estimated to comprise over 50% of dried fish sold on the market in Zambia.

Material and Methods

Split, dried, smoked bream (*Tilapia* spp.) were purchased from retailers at Luburma market in Lusaka for the period from August, 1968, to January, 1969. An effort was made so that no retailers would recognize our purpose for buying the fish and our laboratory staff who actually did the

purchasing were instructed to appear as ordinary shoppers. Three to four retailers from whom the fish were bought were randomly selected on each sampling date. At the sampling, the origin of the samples was asked of the retailers.

It was planned to collect four samples weekly but scarcity of the commodity at certain periods caused somewhat irregular distribution of the samplings.

The total number of the samples was 83, Table 1 shows the sources of the sampled product by month. Fish from Barotse province composed over 40% of the samples followed by Kariba (25%) and Kafue (24%). These three fisheries comprised nearly 90% of the total. A market survey in 1964-65 (BEATTY 1969) revealed that only a non-significant amount of dried fish at the Luburma market was supplied from the Barotse fishery. Obviously, this fishery greatly increased its share in the dried fish market in Lusaka during the past three to four years.

The purchased samples were brought back to the laboratory of the C.F.R.I. at Chilanga and weighed individually to 100 mg and then subjected to organoleptic, chemical and bacteriological examinations. The analyses were made on each product.

Firstly, skin surface specimens of 20 to 30 cm^2 were aseptically taken and suspended in 50 ml of sterilized physiological saline. From this suspension, ten fold dilution was made and coliform counts on violet-red-bile-agar and total aerobic counts on nutrient-agar were determined. Incubation time was 24 hours at 37° C for the coliform counts and five days at room temperatures of 20-25° C for the total aerobic counts.

Secondly, degrees of discoloration, firmness of meat, cleaning defects, insect infestation, mould contamination and odour defects were sensorily assessed by the method of WATANABE and DZEKEDZEKE (1971a). Based on the assessments, overall qualities were scored in a hedonic scale of excellent-10, good-8, fair-6, poor-4, half rotten-2 and rotten-0. Grade A of the Watanabe and Dzekedzeke's method corresponded to 10 to 8 of the hedonic scoring, Grade B to 6 to 4, Grade C to 2 to 0.

As much meat portion of the fish as possible was then separated from bones, head, skin and fins and weighed for estimation of meat percentage. After the weighing, the meat portion was separated into two parts. One part of the meat was boiled for 30 minutes in a 2% NaCl solution and the eating quality of the meat was determined organoleptically by a semi-trained taste panel composed of four to five members of local laboratory staff. The scoring was made in ten point scale. The training of the panel

Table 1. Monthly Distribution of the Origin of Dried, Smoked Bream Sampled from Luburma Market in Lusaka

	← 1968					1969		
Origin	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Total	%
Barotse (including Sesheke Fishery)	2	3	2	2	16	10	35	42.2
Kariba	4	2	2	9	4	0	21	25.3
Kafua	0	0	0	3	5	12	20	24.1
Lukanga	0	2	0	0	0	2	4	4.8
Rukwa (Tanzania)	0	0	2	0	0	0	2	2.4
Mweru	0	1	0	0	0	0	1	1.2
Total	6	8	6	14	25	24	83	

Table 2. Average Values and Ranges of Proximate Composition, pH, Bacterial Counts and Organoleptic scores of Dried, Smoked Bream Sampled from Luburma Market in Lusaka

No. of Samples[1]		Proximate Composition %				pH	Bacterial Counts/ cm² Skin Surface		Appear-[2] ance and smell score	Fish size by Weight Cooked[2] Meat Score	g	Meat %
		Water	Ash[3]	Oil[3]	Protein[3]		Total Aerobic	Coliform				
83	Average	17.4	4.9	11.2	66.5	6.60	1,200,000	450	5.7	6.1	179	38.3
	Range	5.2–51.0	2.3–12.1	1.4–39.9	40.2–84.1	6.06–8.53	< 10–44,000,000	< 10–14,000	2.0–10.0	2.0–9.1	60–416	13.9–64.7

(1) Samples were collected for the period August, 1968–February, 1969.
(2) Scores: Excellent 10, Good 8, Fair 6, Poor 4, Half rotten 2, Rotten 0.
(3) Wet basis.

members and the method of the scoring based on those reported earlier (WATANABE 1962).

The other part of the fish meat was cut into fine particles by a blender and mixed as thoroughly as possible and subjected to chemical analysis. Proximate composition and salt content were determined by A.O.A.C. methods (ANON. 1965) and pH by a glass electrode pH metre.

Average Values of Proximate Composition, pH, Bacterial Counts and Organoleptic Scores

Table 2 summarizes average values of water, ash, oil, protein content, pH, total aerobic counts, coliform counts and scores by organoleptic tests.

Compared with dried Lake Tanganyika sardine (WATANABE 1971) these products contained more water and less ash. Oil and protein content of the two products resembled each other, hence they were similar in caloric values per unit of edible portion.

The pH of the dried smoked bream was 0.6 points higher than that of dried Lake Tanganyika sardine.

Both total aerobic and coliform counts were recorded at fairly elevated levels. The former was over one million and the latter was hundreds per square centimetre of skin surface, but these figures were less than those of the dried sardine. This difference may partly be accounted for by the inclusion of intestinal contents for the analysis of the sardine products. No detailed analysis of the total aerobic flora was done but some microscopic observation on isolates from several samples revealed that the majority of the flora was composed of cocci, mainly of Streptococci and Staphylococci, which were most likely of secondary contamination. The presence of these micro-organisms poses the potential hazard of food poisoning if the products are consumed non-cooked. The main local dish made from this product, however, is a stew mixed with some vegetables which has a very long cooking time of two to three hours. This long cooking time would destroy almost all the bacteria, eliminating such a danger.

The average scores of appearance and smell as well as of cooked meat were fair. Compared with that of the Lake Tanganyika sardine products, the average score of cooked meat was one point less. This finding is contrary to the general belief that the Zambian prefers the dried bream to the dried sardine. Members of our taste panel were generally not satisfied with the presently marketed products and expressed the opinion that the eating quality should be improved. Fresh bream, especially from Kariba, were frequently found to be muddy in taste (WATANABE 1965-66). This defect, however, was never noticed on the smoked, dried samples in the present experiments. The smoky flavour may have masked the muddy taste.

The average weight of the dried fish was 179 g, 40% of which was meat.

Salt Content

At the beginning of 1967, the determinations of salt content were carried out on dried bream collected from the same market in Lusaka, although on a smaller scale than the present one. For comparison purposes the former results are included in Table 3

Table 3. Comparison of Salt Content in Dried, Smoked Bream Collected from Luburma Market in Lusaka between 1967 and 1968–69.

		Period: February–April 1967	August 1968 to January 1969
Salt Content	Number of Samples	29	83
	Average	0.5	1.2
	Range	0.1–1.1	0.1–9.4

which shows the average salt content and its range for the products.

The average value of percentage of salt in this survey was 140% higher than that of the last survey and varied widely between 0.1% and 9.4%. From this observation it is reasonably concluded that some of the sampled fish in the present survey were salted, while none was so processed in the 1967 trials.

To sort out salted fish from non-salted ones the level of 1.5% salt on wet basis was empirically decided as the borderline differentiating the two categories of the product It was then found that 14 samples (17%) were salted, of which 10 were from Kariba and two each from the Kafue and Barotse fisheries.

Since 1966, the C.F.R.I. has developed an improved method of preparing split, dried, smoked bream involving a light salting process (WATANABE and CABRITA 1971). There was a widely believed opinion that Zambians would never accept salted fish because of unfamiliarity of the products in the local markets. Despite this pessimistic prospect, efforts have been made to train not only the Fisheries Department extension staff but also fishermen, chiefly at the Department's Sinasongwe Fisheries Training Centre on Lake Kariba. The results in Table 3 apparently show that the efforts have been successful in persuading local fishermen to adopt the improved method and to produce salted, dried fish. Furthermore, the products were already on the market and accepted by local consumers. It is also interesting to note that the salting method seemed to be first adopted by Kariba fishermen who were most accessible to the training given at the Centre. The method is now in the process of spreading into the Kafue and Barotse areas neighbouring Kariba.

As stated above, of the 21 samples from Kariba, 50% were salted. A comparison between the salted and the non-salted products of Kariba bream is, therefore, made (Table 4).

Proximate composition and pH of the salted fish were quite similar to those of the non-salted, whereas bacterial counts of the former were markedly less than those of the latter. There was little difference in the result of organoleptic tests. Both types of the product were scored as being of fair quality. These results are rather disappointing since once salted a great deal of improvement in the eating quality of the product has been expected as seen in the data obtained from experiments conducted previously on taste preference for salted and non-salted dried fish (WATANABE and DZEKEDZEKE 1971b).

Those disappointing results might have been due to the processors' mispractice of salting only those fish which were either of poor quality at landing or of salting only larger fish (note in Table 4 that the salted ones were 40% heavier than the non-salted) which if not salted tend to become spoiled during the normally prolonged drying time. In either case the dried products are bound to be inferior in quality to those produced from good fresh and smaller sized fish.

In addition to the above reasons, the fish were not salted up to the level recommended. Average salt content of the salted fish was 4.4% which was far less than the 8-10% recommended by the improved method (WATANABE and CABRITA 1971). This factor might also have contributed by causing spoilage at the initial stage of drying resulting in the lower organoleptic scores than expected. Fish processors should be made aware of this finding and encouraged to increase the salt content up to the proposed level.

Variation of the Parameters by Origin

Chemical, bacteriological and organoleptic values of the product varied by their sources. The breakdown of the data in

Table 4. Comparison in Proximate Composition, Salt Content, pH, Bacterial Counts and Organoleptic Scores between Salted and Non-salted Dried, Smoked Bream Produced on Lake Kariba

	Sample No.	Proximate Composition %						Bacterial Counts/ cm² Skin Surface		Appear-[1] ance and smell score	Cooked[1] Meat score	Fish size by Weight g
		Water	Ash[2]	Oil[2]	Protein[2]	Salt[2] %	pH	Total Aeobic	Coliform			
Salted	10 Average	13.6	5.8	16.5	61.1	4.4	6.50	9,500	<10	6.0	6.0	270
Non-Salted	11 Average	21.0	5.6	11.1	62.3	0.7	6.66	5,900,000	170	5.6	5.9	193

(1) Score: Excellent 10, Good 8, Fair 6, Poor 4, Half Rotten 2, Rotten 0.
(2) Wet Basis.

Table 5. Average Values of Proximate Composition, Salt, pH, Bacterial Counts, Organoleptic Scores, Fish size and Meat % by Sources

Sources	No. of Samples	Proximate Composition %						Bacterial Counts/ cm² Skin Surface		Appear[1] ance and Smell-Score	Cooked[1] Meat Score	Fish Size by Weight g	Meat %
		Water	Ash[2]	Oil[2]	Protein[2]	Salt[2] %	pH	Total Aerobic	Coli-form				
Barotse	35	18.9	4.8	11.5	64.9	0.7	6.57	1,000,000	990	6.4	6.5	184	42
Kariba	21	16.7	5.7	14.7	62.9	2.4	6.58	2,500,000	89	5.8	6.0	227	34
Kafue	20	18.4	4.5	7.4	69.7	0.7	6.66	390,000	>10	4.7	5.9	120	35
Lukanga	4	11.5	4.5	10.8	73.3	0.7	6.49	530,000	—	5.5	6.2	234	30
Rukwa (Tanzania)	2	7.6	4.8	10.2	77.5	—	6.66	350,000	—	4.0	6.6	113	38
Mweru	1	6.6	4.7	15.8	72.9	0.7	6.78	200,000	—	2.0	1.5	202	40

(1) Score: Excellent 10, Good 8, Fair 6, Poor 4, Half Rotten 2, Rotten 0.
(2) Wet Basis.

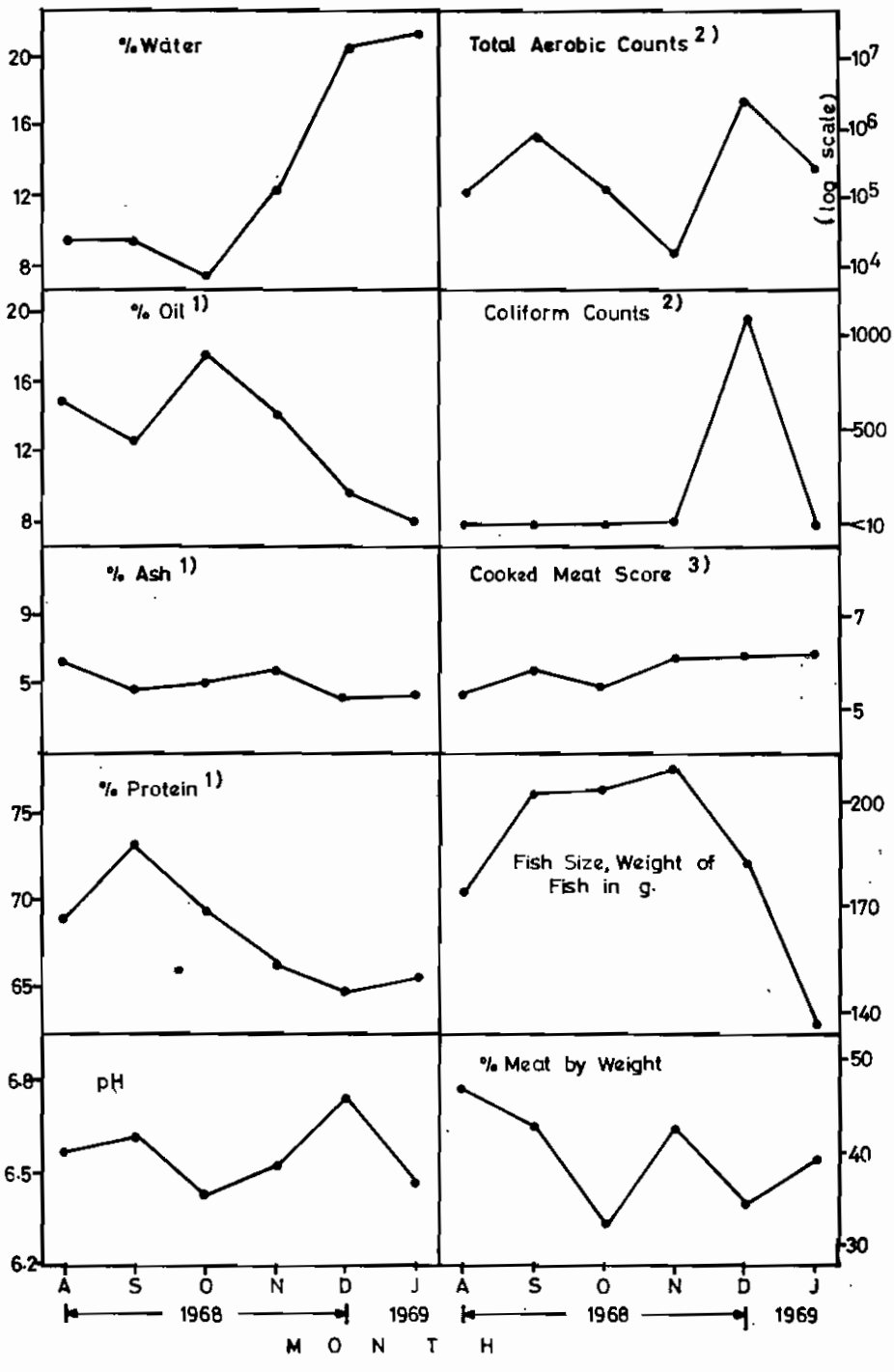

Figure 1. Monthly changes of proximate composition, pH, bacterial counts, cooked meat scores and meat % of dried, smoked bream sampled from Luburma market in Lusaka.

Each point is average of 6 to 25 determinations.

(1) Wet basis
(2) Per Square Centimetre of skin surface
(3) Score: Excellent 10, Good 8, Fair 6, Poor 4, Half Rotten 2, Rotten 0.

Table 1 by origin of the products is shown in Table 5. The number of samples taken from Lukanga, Rukwa and Mweru was too small, hence the following discussion is limited to the other three areas. Water content of the Kariba products was lower than that of the others, but the oil content was distinctly higher. As discussed in the previous section, salt content of the Kariba product was higher than the other. There was little difference in pH among the three areas. With regard to bacterial counts, those of Kariba and Barotse products were higher in the total aerobic while the Barotse product was the highest in coliform counts. Organoleptically, the Barotse product scored the highest mark which was 0.5 points higher than the others. The very dry climate which exists year round in the Barotse fishery would have helped dry fish rapidly and thus prepare a product of better quality.

Individual Kariba fish were considerably heavier than the others. This might have made drying more difficult, resulting in the poorer eating quality of the dried product from this fishery.

Monthly Changes in the Parameters

Fig. 1 shows seasonal variation of the analysed values.

Water content increased from 8% in the dry season of October to 20% in the rainy season of December to January, which was reciprocated by the decrease of oil and protein content. A similar tendency was also observed in the dried Lake Tanganyika sardine (WATANABE, 1971), but the variation of the present products was much wider. Ash content was fairly constant at around 5%. Total aerobic and coliform content and pH had their highest peaks in December. Little change by month was noted in cooked meat scores. Individual fish size decreased from over 200 g in the dry season of September to November to 140 g in the wet season of January. This may be due to seasonal movement of fish or the fishermen's habit in this season to set nets where smaller fish were more abundant. Whichever the reason, this decrease in size of fish during the rainy season facilitates the drying of fish in this otherwise unfavourable period and would account for the fairly constant level of the quality of the products.

Some of the changes, especially the increase of water content in the finished products in the rainy season, are undesirable from the viewpoint of uniformity in the quality and shelf-life. To avoid these undesirable changes due to climatic conditions, the use of plastic bags should be considered. Packing the fish products in plastic bags may also assure reduced secondary bacterial contamination, thus improving the hygienic condition of the products.

Relationships of Cooked Meat Scores to the Other Parameters

Assuming that relationships between cooked meat scores and the other variations are linear, regression (b) and correlation coefficients (r) between the organoleptic scores and each of appearance and smell score, per cent water, per cent oil, pH, log (total aerobic counts), fish size and per cent meat were calculated. The results are summarized in Table 6.

These two coefficients are useful in selecting parameters which can be employed as indices for determining the eating quality and in this sense provide a basis for the quality standards. The closer to ± 1.0 both coefficients of a certain parameter are, the more suitable the parameter is to be used for the quality standards. But, for the direct comparison of the regression coefficient among the various parameters, the regression coefficient figures should be adjusted to the equal level of responsiveness by equalizing the digital number over decimal point of the actual figures of the parameters. It was

Table 6. Statistical Analysis of the Relationship of Cooked Meat Scores to the Other Parameters

Parameters	DF[1]	Regression Coefficient b	Adjusted[2] regression b_1	a	Correlation coefficient r	Significance Level, %	b_1, x r
Appearance and Smell Score	81	0.322	—	4.265	0.321	1	0.10
Water %	81	–0.038	–0.383	6.766	–0.242	5	0.09
Oil %	81	–0.049	–0.492	6.160	–0.191	10	0.09
pH	81	–0.913	—	12.130	–0.196	10	0.18
Log (total Aerobic Counts)	81	–0.142	—	6.672	–0.134	—	0.02
Fish size by weight, g.	81	–0.005	–0.486	6.969	–0.229	5	0.11
Meat %	81	0.033	0.326	4.999	0.225	5	0.07

(1) Degree of Freedom.
(2) Adjusted by equalising the digital number over decimal point of the actual figures of the parameters.
(3) a of Fitted Regression Function, $y = a + bx$ where y is Cooked Meat Score.

arbitrarily decided to adjust the actual figures to one digit over decimal point for all the parameters. Then, the regression coefficient of per cent water, oil and meat were multiplied by 10 and that of fish size by 100, the results of which was shown under the column Adjusted regression coefficient, b_1, in Table 6. Thereby, the multiple of the adjusted regression coefficient and correlation coefficient (b_1 x r) for each variate was calculated as a figure useful for evaluating the suitability of each parameter for its use in the assessment of eating quality. Table 6 also includes these figures under the column (b_1 x r). The closer to one that the multiple of a certain parameter is, then the better suited the parameter is to be considered as an index of quality.

Appearance and smell score showed the best correlation with cooked meat score at the 1% significance level. The regression coefficient between the two parameters was positive and fairly high. Fig. 2 shows graphically the relationship. It indicates that when the fish appearance was good the eating quality averaged fair and the cooked meat score varied between poor to good, whereas at lower appearance scores this relationship was reversed. Even if appearance was poor, the products tasted a little better than poor.

Per cent water was correlated significantly with the cooked meat scores at the 5% level, but the regression coefficient between the two was rather small and negative. This implies that there was a significant and responsive relation; the drier the product, the better the eating quality.

Both per cent oil and pH showed correlation with the cooked meal scores only at the lower significant level of 10%. The regression coefficient for pH, however, was very close to 1, signifying that this parameter was highly responsive to the changes in eating quality, whereas per cent oil was less responsive to the changes in the quality than pH. The regression coefficient of the two parameters are both negative, therefore, the lower the oil content and pH of the dried products, the better the eating quality.

There was no significant correlation between total aerobic counts and the cooked meat score. In other words, those counts cannot be applied to indicate the eating quality of split, dried, smoked bream in Zambia.

Fish size and per cent meat showed significant correlation to the cooked meat score

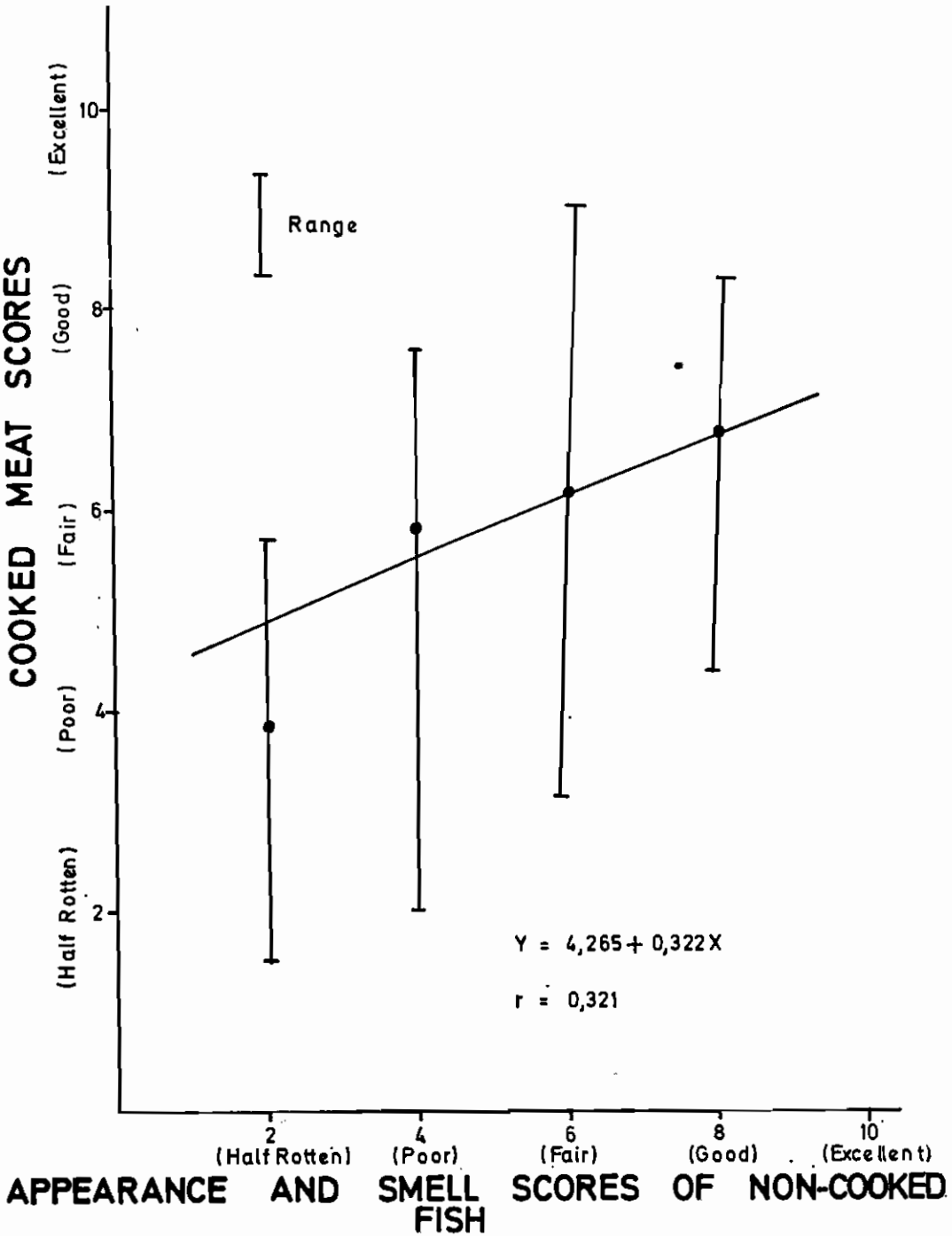

Figure 2. Relationship between appearance and smell score of non-cooked fish and cooked meat scores of dried, smoked bream.

at the 5% level. The adjusted regression coefficient of the fish size was reasonably high to be effectively employed as an index of the quality. Per cent meat is chiefly related to the degree of beetle infestation of the products. When the products are heavily infested with beetles a low percentage of meat and also lower taste score due to off-flavour possibly caused by the beetles (PROCTOR 1972) were expected. This expected relationship was partially proved by the positive regression coefficient for per cent meat, but the responsiveness of this parameter to the changes in the cooked meat was comparatively small.

Overall, the multiple figures of b_1 x r for total aerobic and per cent meat were so small that they could not effectively reflect the differences in eating quality of the fish products. The pH reading had the highest figure of this multiple followed by fish size and appearance and smell score, and those of water and oil content were equal at 0.09. Percent of water, however, would be a better choice of the two because of its higher correlation coefficient. Also, in practice, the determination of the per cent water is easier than that of oil content. Thus it is concluded the pH, fish size, appearance and smell score, and per cent water are the parameters suitable for assessing the eating quality of split, dried smoked bream presently marketed in Zambia.

SUMMARY

From August, 1968, to January, 1969, eighty-three split, dried and smoked bream (*Tilapia* spp.) were periodically sampled from Luburma market in Lusaka, Zambia, and subjected to chemical, bacteriological and organoleptic analysis. The purpose of this critical survey on the market quality was to obtain basic information for the development of national quality standards for the commodity.

Proximate composition, salt content, pH, total aerobic counts, coliform counts, appearance and smell scores, and cooked meat scores were determined.

Water content varied seasonally between 8% and 20%, with an average of 17%. The average value of total aerobic count was high (over one million per square centimetre of skin surface). Both appearance and smell scores and cooked meat scores averaged out at around fair.

Statistical analysis of the relationships of cooked meat scores to the other parameters indicated that pH, fish size, appearance and smell scores, and percentage of water can be used as indices for quality standards of the products.

ACKNOWLEDGEMENTS: This paper was prepared as part of UNDP/FAO/GRZ Central Fisheries Research Institute Project in Zambia. This paper is published by permission of the Food and Agricultural Organization of the United Nations. The views expressed are those of the author and do not necessarily coincide with those of the Organization.

REFERENCES

Anon. (1965). *Official Methods of Analysis*, 10th ed. Ass. Off. Agric. Chemist, Washington, D.C., 419 p.

Beatty, D. M. F. (1969). Results of a Fish Marketing Survey in Zambia, 1964-65. Ministry of Rural Development, Department of Wildlife, Fisheries and National Parks, Zambia. Occasional paper—Table 5.12b.

Proctor, D. L. (1972). The Protection of Smoke-dried Fresh Water Fish from Insect Damage During Storage in Zambia. *J. stored. Prod. Res., U.K., 8,* 149 p.

Watanabe, K. (1962). Nota sôbre provas de gustaçao para a determinaçao da qualidade de peixes cozidos. Contribuiçoes avulsas do Instituto Oceanográfico, Série Technologia No. 4, Instituto Oceanográfico, Universidae de Sao Paulo, Sao Paulo.

Watanabe, K. (1965-66). Handling and Keeping Quality of Iced Kariba Bream. *Fish. Res. Bull. Zambia, 4,* 63 p.

Watanabe, K. (1971). Chemical, Baeteriological and Sensory Examination of dried Lake Tanganyika Sardine presently marketed in Zambia. *Afr. J. Trop. Hydrobiol. Fish.,* No. 2, *1,* pp. 115-129.

Watanabe, K., and Cabrita. F. J. (1971). Direction for the Preparation of Salted and Dry-smoked Fish. *Fish. Res. Bull. Zambia, 5,* 228 p.

Watanabe, K., and Dzekedzeke, O. (1971a). Recommended Zambian standards for grades for split, dried, smoked beam (*Tilapia* spp.). *In* Fish Inspection and Quality Control, Ed. R. Kreuzer. Fishing News (Books) Ltd., London.

Watanabe, K., and Dzekedzeke, O. (1971b). Taste Preference of Zambians on Various Types of Dried and Smoked Fish. *Fish. Res. Bull. Zambia, 5,* 199 p.